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# PATENT SPECIFICATION

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DRAWINGS ATTACHED



1 211 849

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## (54) IMPROVEMENTS IN AND RELATING TO HEAT TREATMENT OF ALUMINIUM FOIL

(71) We, ALUMINIUM FOILS LIMITED, a British Company, of Norfolk House, St. James's Square, London, S.W.1, formerly of Thorn House, Upper St. Martin's Lane, London, W.C.2, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with improvements in and relating to the heat treatment of aluminium foil.

Aluminium foil is heated during many processes applied to it, including simple annealing of the foil itself. Thus decorative lacquers and prints applied to the foil are dried by heating the foil, as are heat sealable coatings or protective coatings applied as a solution or dispersion of a resinous base in a solvent or liquid vehicle. Last traces of rolling lubricant can be removed by heat. Thermosetting resins used for example for protection or for electrical insulation are hardened by heat and heat fusion will often improve the adhesion of coatings to the foil.

Methods commonly adopted for drying continuous coatings or print on aluminium foil include passing the foil over heated surfaces or blowing large volumes of heated air over the foil surface. These methods are comparatively wasteful of heat and, particularly where hot air is blown over the surface of the foil, there is danger of the coating forming a surface skin under which solvent can be locked, escaping later into the product packed in the foil. Where the foil contacts a hot surface care has to be taken to regulate the heat so that undue creasing does not take place owing to expansion of the metal, which creasing cannot later be removed.

The present invention provides a method of heat treatment of aluminium foil, wherein a web of the foil, to which a coating sub-

stance as above described may have been applied, is passed successively in electrical contact with a set of three or four spaced electrically conducting rollers while a heating electric current is passed in the case of three rollers between the intermediate roller and each of the two outer rollers and in the case of four rollers between each of the two intermediate rollers and its corresponding outer roller, the relative positions of the rollers in each set being adjustable so that the paths of the web between the single intermediate roller and each outer roller or between each intermediate roller and its corresponding outer roller can be varied to adjust the resistances, and therefore the temperatures, in the two lengths of web through which the current passes.

Preferably the web is passed over each of the rollers, the angle between the arriving and departing portions of the web being in each case sufficiently below 180° to ensure good electrical contact.

Apparatus for use in a method of the invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a representation of a three roller system in end elevation,

Fig. 1a is a circuit diagram of this system,

Fig. 2 is a similar representation to Fig. 1 of a four roller system and

Fig. 2a is a circuit diagram of the latter system.

Referring to the drawings, a web of aluminium foil 1 is passed in either direction over electrically conducting supporting rollers, in Fig. 1, 1a, 2 and 1b and in Fig. 2, 1a, 2a, 2b and 1b.

In Fig. 1, apart from the supporting rollers, there is no other guiding means for the web between the outer bounding rollers 1a and 1b. In this case good electrical contact between the rollers and the web is ensured

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by positioning the roller 2 somewhat higher than the rollers 1a and 1b and by passing the web in the path shown.

In Fig. 2, all the supporting rollers are at the same level and an insulated control roller 3 is provided above the web between the rollers 2a and 2b, the web being caused to take the path shown. In all cases, therefore, the web is brought into good electrical contact with the supporting rollers.

The source of electricity is the secondary 4 of a transformer 5. In each case the two outer rollers are both connected to one side of the secondary winding of the transformer and earthed. The intermediate roller or rollers are connected to the other side of the secondary winding.

In Fig. 1 it is indicated by means of arrows that the position of the roller 2 is laterally adjustable. This is for the purpose of varying the resistances, as necessary, by adjusting the foil lengths between rollers 1a—2 and 2—1b. This is indicated in Fig. 1a by a resistor 6a—6b with tapping point at 7.

The adjusted resistances may be equal or different as indicated below.

In a similar manner, in Fig. 2, both of the rollers 1a and 1b are shown to be adjustable, while both of the rollers 2a and 2b are fixed, and in Fig. 2a the central fixed resistor indicates the fixed length between rollers 2a—3—2b, while the outer resistors are shown tapped at 8a and 8b, this indicating a possible variation of the foil lengths between rollers 1a—2a and 2b—1b respectively.

The process of the invention allows very efficient use of energy in heating aluminium foil while it is in motion and easy control of temperature both by regulating the amount of energy supplied and also if desirable or necessary by allowing the temperature to be raised by a series of controlled steps. Solvent retention is minimized as compared with hot air drying and "heat creasing" can be kept within acceptable limits.

Only a low voltage e.g. under 10 volts is necessary but a high amperage will be required. Thus for example a current of 800 amps at 3—4 volts passed through a 15" length of foil 12" wide and 0.018 mm in thickness which is travelling at 225 ft/min will raise the foil temperature to 120°C.

To minimise creasing due to expansion of the metal, which is especially likely at the high foil temperatures, for example 150°C—200°C, necessary for rapid stoving of epoxy resins, the temperature can be brought up in stages.

The steps can be controlled by varying the distances between the inner roller or rollers and the outer rollers as described above.

The rollers can be spaced as is convenient. Particularly for light gauge foil it is better not to have any lengths of unsupported foil in excess of 2 feet and here it may be advantageous to carry the foil over additional insulated support rollers. By raising or lowering these latter rollers it is possible further to adjust the length of travel between current carrying rollers.

The conducting rollers may be of any convenient conducting material and in order to obtain an even distribution of current flow through the material and through the rollers, both ends of each current collecting roller should be connected to the secondary windings. For lightness these rollers may be hollow aluminium shells having sufficient cross section to allow free current flow with steel inserts at each end to provide hard wearing machined journals for mounting the rollers on bearings. Flat ends of the journals can be utilised as commutators for collecting current from carbon/copper brushes. When sufficiently light, the rollers can be driven by friction with the moving web of foil. High contact area without excessive lap is of advantage in avoiding creasing and too small a roller diameter should therefore be avoided. A diameter of 6" gave excellent results but greater diameters e.g. 12" may be employed.

The heating process of this invention can be applied not only for the complete drying of coatings, inks or adhesives, or for stoving, but can be used in conjunction with existing plate to boost drying or stoving, thereby increasing machine speed or producing a better quality product. The foil can be light gauge e.g. 0.009 mm, medium gauge e.g. 0.03 mm, or heavy gauge e.g. 0.1—0.15 mm. The temperature reached is determined by the power applied, the speed of travel, the volume of the foil and the area of exposed foil surface and where liquid is evaporated, the amount and specific heat of this liquid.

While D.C. current can be employed, the greater possibility, as compared with A.C., of arcing if the D.C. current path is broken, as well as the greater general convenience of A.C., makes A.C. preferable.

#### WHAT WE CLAIM IS:—

1. A method of heat treatment of aluminium foil, wherein a web of the foil is passed successively in electrical contact with a set of three or four spaced electrically conducting rollers while a heating electric current is passed in the case of three rollers between the intermediate roller and each of the two outer rollers and in the case of four rollers between each of the two intermediate rollers and its corresponding outer roller, the relative positions of the rollers in each set being adjustable so that the paths of the web between the single intermediate roller

- and each outer roller or between each intermediate roller and its corresponding outer roller can be varied to adjust the resistances, and therefore the temperatures, in the two  
5 lengths of web through which the current passes.
2. A method as claimed in claim 1, wherein the web is passed over each of the rollers, the angle between the arriving and  
10 departing portions of the web being in each case sufficiently below  $180^\circ$  to ensure good electrical contact.
3. A method as claimed in claim 1 or 2, wherein alternating current is employed.
4. A method as claimed in claim 1, 15 substantially as described herein with reference to Figs. 1 and 1a or Figs. 2 and 2a of the accompanying drawings.

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COMPLETE SPECIFICATION

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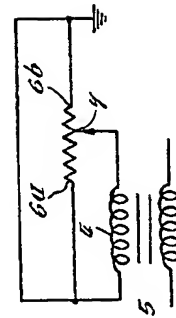
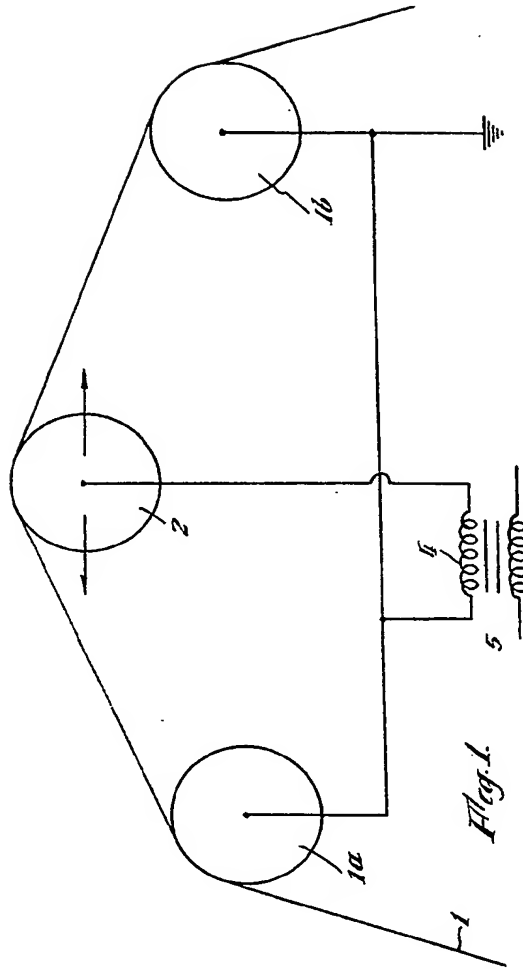
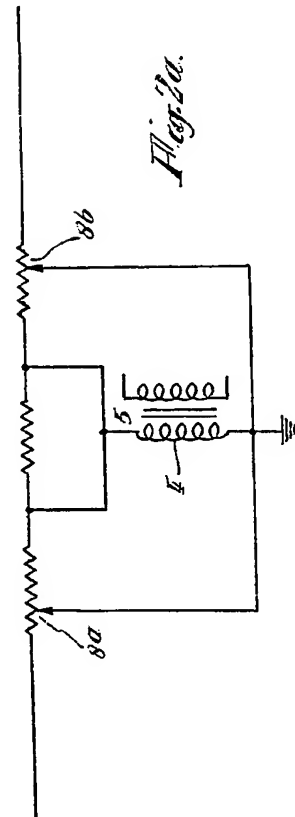
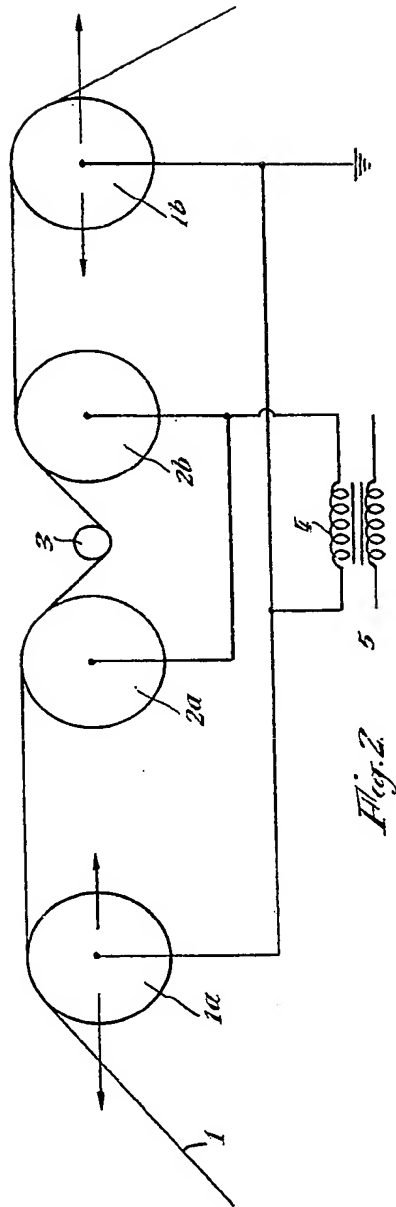


Fig. 1a.



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